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Finally in Fig. 7, $\alpha = \beta = 52°$. The starting and cusp circles and the 0° line of the tangent circle are the same as usual. The cusp C however is now at O, and the 0° line of the radii vectores through it is the negative direction of the Y axis. F has shifted somewhat and the intersection circle is much reduced.

COLLEGIATE MATHEMATICS FOR WAR SERVICE.

Send communications for this department to H. Blumberg, University of Illinois.

STATISTICS IN RELATION TO THE WAR.

By Roxana H. Vivian, Wellesley College.

Before 1914 there were many lines of work where the material dealt with was known to have the characteristics of statistical data, and to require treatment by one of the various statistical methods. Since 1914, not only are there many more fields where statistical methods are required because of their development in connection with war problems, but also, in the already established domains of statistics, the quantities to be collected and placed in systematic form for drawing conclusions have grown beyond the earlier proportions and require much more attention. Every new National Council or local committee needs immediate records of present conditions, and usually of the past as well. There is a growing interest in such statistical data and a desire for trained workers in large centers who can, and will, avoid expensive duplication in collecting, and who are able to present the authoritative abbreviated tables and charts that executive committees especially need.

This situation is withdrawing statistics from its position as a somewhat unpopular subject, and thoughtful workers and educators are making an effort to cancel the criticisms from which it has suffered because statistical problems were so often handled by inexperienced manipulators in ways that led to conclusions and plans that were disastrous in business and ludicrous in science. To schools and colleges this brings an opportunity for contributing certain preparation that is especially desired in the present emergency for the young men and young women who are being called to enter business, scientific, or government fields with the possibility of assuming some collection and supervision of statistical material, as well as the opportunity of giving to those who are going into different branches of military, naval or engineering service the underlying theory in those lines that the college class-room can so quickly furnish. For those who must present accurate tables of figures and draw far-reaching conclusions in the war problems of finance, research, national and international resources, the general background of college training is a substantial asset; and if to the general background there can be added even a brief elementary course in the mathematical foundations of statistics, a graduate is ready to enter more quickly into a responsible position and give reliable and necessary assistance.

This is not entirely a new point of view. For some years it has been evident that in many college subjects students need information in regard to statistical methods, as well as so-called statistics. Courses that deal with the general fundamental theory that is essential in any field have been introduced in various institutions. Except in a vocational institution where up-to-date files and computing machines are available, it is practically necessary to offer such work as a lecture course with special problems—that is, problems that require a minimum amount of time in collecting, tabulating, and making computations before drawing conclusions, and which yet afford opportunities for experimenting with all the known statistical methods and choosing the right one.

In attempting to present such work as a war emergency course, the situation differs very little from the problem of presenting the elements of statistical theory to a group of students whose college interests, or after-college plans, embrace all the natural sciences, psychology, education, economics, institutional accounting, commerical offices, municipal and governmental positions. The fundamental theory remains practically the same, the reading, required or suggested, can be slightly varied, and the problems can be chosen from the most essential fields of the present day, in the regions which are most open to the students. Such an arrangement is possible, although it may mean omission for the present of many of the interesting or vital sections of the subject, such as details of the history of government statistics in Belgium under Quêtelet, the development of insurance statistics beyond the possibility of business failure, the peculiar difficulties of early health statistics, and many more. The subject may still be presented after this adjustment as a combination course, which includes pure theory, supplemented by varied reading, with brief but ample work along especially suitable lines.

Books dealing with statistics can be found in many languages, but the standard collection for American students must be largely in English. During this year several new American books on statistics have been published and take their place among the older English and American volumes. Since they are all written from varying points of view, and since hardly one of the elementary books is sufficiently general, a reading shelf seems to be a prime necessity in beginning the study of statistics. In addition to this, careful references must be given to prevent a student from losing valuable time in securing the important first principles that are needed in all statistical work. Frequently a chapter will treat a simple collection by an advanced method, or a simple principle may be so veiled by logic, or by mathematics, as to be unrecognizable except by an expert in these lines. Part of the reading that can be done in such a collection becomes practice in extricating information, part furnishes the realization of how extremely varied and universal statistical problems and methods are, and the criticism of methods used by others leads often to the invention of new forms and short cuts by the student himself. Every one of these factors is an essential part of the mental resources of the future statistical clerk or statistician.

Daily, weekly, and monthly publications which students are reading today with concern as to their accuracy and their predictions for the future, furnish problem material of deeper interest than many of the best and most convenient collections of preceding years. Questionnaires for registration show bewildering sources of difficulty in collecting material. Reports on daily receipts in Liberty Bond campaigns raise questions as to the complete reliability of published figures, and the necessity of checking results, and publishing the same with authorized signatures. Income tax classifications, national budget items, and appropriation lists with their large figures, are much more interesting to the average student and reveal problems which are more vital to him than the reports of corporations, organizations, and institutions, which were the usual forms of illustrating financial matters in statistics before the war. National vital statistics, and military and naval figures have put most of the scientific statistical data into the background; but since the methods remain the same the variation in material is relatively unimportant.

How such material shall be dealt with by students depends very much upon the recognized dividing line between academic and vocational courses. If adding machines are available, students can be taught to use them in a very short time, and more extensive problems can be undertaken without abnormal use of study hours for long clerical calculations. Unless such work includes obtaining information in regard to the mathematical principles of computation, and their application to machine computation, and unless the larger problems in collecting material and computing averages, percentages, deviations, and other figures are mentally worth the time they require, they lie outside the limits of a standard course for a college student. It is an interesting feature of the increasing demand for college courses in statistics that students will add, at an expense of their own time and money, an element of training which is vocational and not academic, namely, clerical experience with statistical collections once a week in some well-organized business office or municipal bureau where the exchange of collegiate theory for office experience seems to be a mutual and welcome courtesy.

The conclusion is rather a natural one that statistics with its steady general theory helping out the changing situation in these many fields is a worthy member of our mathematical family. The relation of the whole family to the war situation seems to be the customary one. It was jogging along as best it could and in the face of much unpopularity. Now the call comes to each member in this emergency; and statistics and all the other steeds are changing their harnesses and cutting across every field they can to reach the most strenuous and exacting positions and to carry the national problems to the speediest and best solution. Every institution and every instructor furnishing graduates who can assist in this particular drive is making a worthy contribution to the work of the war.

Note 1.—A few of the books advisable for a reading shelf for elementary statistical theory are the following:

Bailey & Cummings—Statistics.
Block—Traité Théorique et Pratique de Statistique.
Brinton—Graphic Methods.

Copeland—Business Statistics.
Elderton—Primer of Statistics.
King—Elements of Statistics.
Secrist—Introduction to Statistical Methods.
Thorndike—Mental and Social Measurements.
West—Introduction to Mathematical Statistics.
Yule—Introduction to the Theory of Statistics.

There are many that can be added along more general lines, and the *American Statistical Quarterly* and other magazines are furnishing an increasing number of articles on the statistical questions of the day.

Note 2.—Wellesley graduates who have had a one-hour per week course in statistical theory have secured positions in the Statistical Division of the Shipping Board and of the Labor Bureau. Their college work has covered, as completely as was possible in a short course, the collection and arrangement of statistical data, questionnaire forms, classification, graphic representation, computation of averages, percentages and deviations, methods of checking results, index figures, graphic comparison, and correlation.

PROBLEMS FOR SOLUTION.

SEND ALL COMMUNICATIONS ABOUT PROBLEMS TO B. F. FINKEL, Springfield, Mo.

2737. Proposed by C. N. SCHMALL, New York City.

Employing Maclaurin's Theorem, or otherwise, expand the following three functions: (1) $\epsilon^{\tan^{-1}x}$ as far as x^6; (2) $\epsilon^{\sin x}$ as far as x^8; and (3) $\tan x$ as far as x^9.

2738. Proposed by W. D. CAIRNS, Oberlin College.

Prove that between any two points on a unit circle with its center at the origin there is a point whose coördinates are rational, *i. e.*, prove that the rational points on this circle are dense.

2739. Proposed by JOS. B. REYNOLDS, Lehigh University.

A particle is describing a smooth closed curve in a vertical plane. This curve is three feet high, $19\pi/4\sqrt{2}$ ft. long, and of such form that the pressure is always constant. Find the time of a complete revolution.

2740. Proposed by E. W. CHITTENDEN, University of Illinois.

Establish the identity (the determinant is of order n):

$$\begin{vmatrix} a-\lambda, & a, & a, & \cdots, & a \\ a, & a-\lambda, & a, & \cdots, & a \\ a, & a, & a-\lambda, & \cdots, & a \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a, & a, & a, & \cdots, & a-\lambda \end{vmatrix} = (-1)^{n-1}\lambda^{n-1}(na-\lambda).$$

2741. Proposed by HORACE L. OLSON, New Hampshire College.

Prove or disprove the following statement: If the three sides and the area of a triangle are integers, at least one of the three altitudes is an integer.